World Academy of Science, Engineering and Technology
International Journal of Nuclear and Quantum Engineering
Vol:14, No:07, 2020

Plasma Ion Implantation Study: A Comparison between Tungsten and Tantalum as Plasma Facing Components

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Abstract : Currently, nuclear fusion is considered one of the most favorable options for future energy generation, due both to its abundant fuel and lack of emissions. For fusion power reactors, a major problem will be a suitable material choice for the Plasma Facing Components (PFCs) which will constitute the reactor first wall. Tungsten (W) has advantages as a PFC material because of its high melting point, low vapour pressure, high thermal conductivity and low retention of hydrogen isotopes. However, several adverse effects such as embrittlement, melting and morphological evolution have been observed in W when it is bombarded by low-energy and high-fluence helium (He) and deuterium (D) ions, as a simulation conditions adjacent to a fusion plasma. Recently, tantalum (Ta) also investigate as PFC and show better reluctance to nanostructure fuzz as compared to W under simulated fusion plasma conditions. But retention of D ions found high in Ta than W. Preparatory to plasma-based ion implantation studies, the effect of D and He ion impact on W and Ta is predicted by using the stopping and range of ions in the matter (SRIM) code. SRIM provided some theoretical results regarding projected range, ion concentration (at. %) and displacement damage (dpa) in W and Ta. The projected range for W under Irradiation of He and D ions with an energy of 3-keV and 1×fluence is determined 75Å and 135 Å and for Ta 85Å and 155Å, respectively. For both W and Ta samples, the maximum implanted peak for helium is predicted ~ 5.3 at. % at 12 nm and for De ions concentration peak is located near 3.1 at. % at 25 nm. For the same parameters, the displacement damage for He ions is observed in W ~ 0.65 dpa and Ta ~ 0.35 dpa at 5 nm. For D ions the displacement damage for W ~ 0.20 dpa at 8 nm and Ta ~ 0.175 dpa at 7 nm. The mean implantation depth is same for W and Ta, i.e. for He ions ~ 40 nm and D ions ~ 70 nm. From these results, we conclude that retention of D is high than He ions, but damage is low for Ta as compared to W. Further investigation still in progress regarding W and T.

Keywords : helium and deuterium ion impact, plasma facing components, SRIM simulation, tungsten, tantalum
Conference Title : ICPPFE 2020 : International Conference on Plasma Physics and Fusion Energy
Conference Location : Toronto, Canada
Conference Dates : July 16-17, 2020